

DYNAMIC CRYSTALLIZATION EXPERIMENTS ON CHONDRULE MELTS IN
REDUCED GRAVITY

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Background

Chondrules crystallized during the earliest formational history of our solar system; and, if crystal settling and flotation are indicators of crystallization in the presence of gravity, they formed without the influence of gravity. In fact, attempts to duplicate the crystallization history of chondrules in the laboratory have met with limited success, because of the difficulty of comparing objects formed under the influence of gravity with objects that did not. These comparisons are difficult because there are several recognized features introduced by the presence of gravity and no doubt some which we do not yet recognize. As a result there are several microscale and macroscale aspects of chondrule petrology which are difficult to understand quantitatively. Most of the features relate to the settling or flotation of early formed crystals; briefly, the major features are:

- (1) Chemical gradients set up because nonuniform distribution of crystals isolate phases from the bulk and influence the chemistry of phases which crystallize subsequently.
- (2) If the distribution of heterogeneous nuclei is affected by gravity, variations of crystal shape can also occur.

- (3) Finally, movement of crystals induces convection-like effects (mixing and flow patterns) in the laboratory experiments which affect the overall texture.

Proposed Experiments

Dynamic crystallization experiments will be carried out in the furnace designed for controlled atmosphere experiments described in this document (see Williams', abstract below). The experiments are designed to look at the effect of reduced gravity on the overall texture of crystallized chondrule melts. The runs will be approximately 24 hrs. long and require maximum temperature of 1400° to 1500°C . The initial experiment would involve heating to the maximum temperature, maintaining isothermal conditions for two hours, cooling at a controlled rate (10° to 20°C/hr.) over the first 200° to 300°C , and then "quenching" by cooling at the natural rate of the furnace by turning the power off. The oxygen fugacities would be maintained slightly above those of the iron-wustite buffer throughout the active phase of the experiment in order to simulate a natural redox state. Three or four charges can be run simultaneously and, thus, the effect of heterogeneous nucleation can be evaluated by varying the composition sufficiently to place the liquidus of some charges above and some below the run temperature. Ground-based experiments would be performed to compare results. A sequence of three or four experiments (each with three or four samples) would be needed to adequately explore the effects of gravity on a relevant suite of compositions. Other experiments such as isothermal crystallization induced by changes in the oxygen fugacity would be investigated in subsequent experiments.